Handling High Activity Components on the SNS

(Collimators & Passive Dump Windows)

Graeme Murdoch

Mechanical Systems Group

May 19-23, 2003

Outline

- The Spallation Neutron Source
- Anticipated Accelerator Hot-Spots
- Ring Lattice
- Collimation Layout
- Collimator Removal Procedure
- Remote Water Fittings
- Remote Vacuum Clamps
- Primary Collimator & Moveable Scraper
- Linac Passive Dump Window – Active Handling
- Summary
- Future Work/Challenges

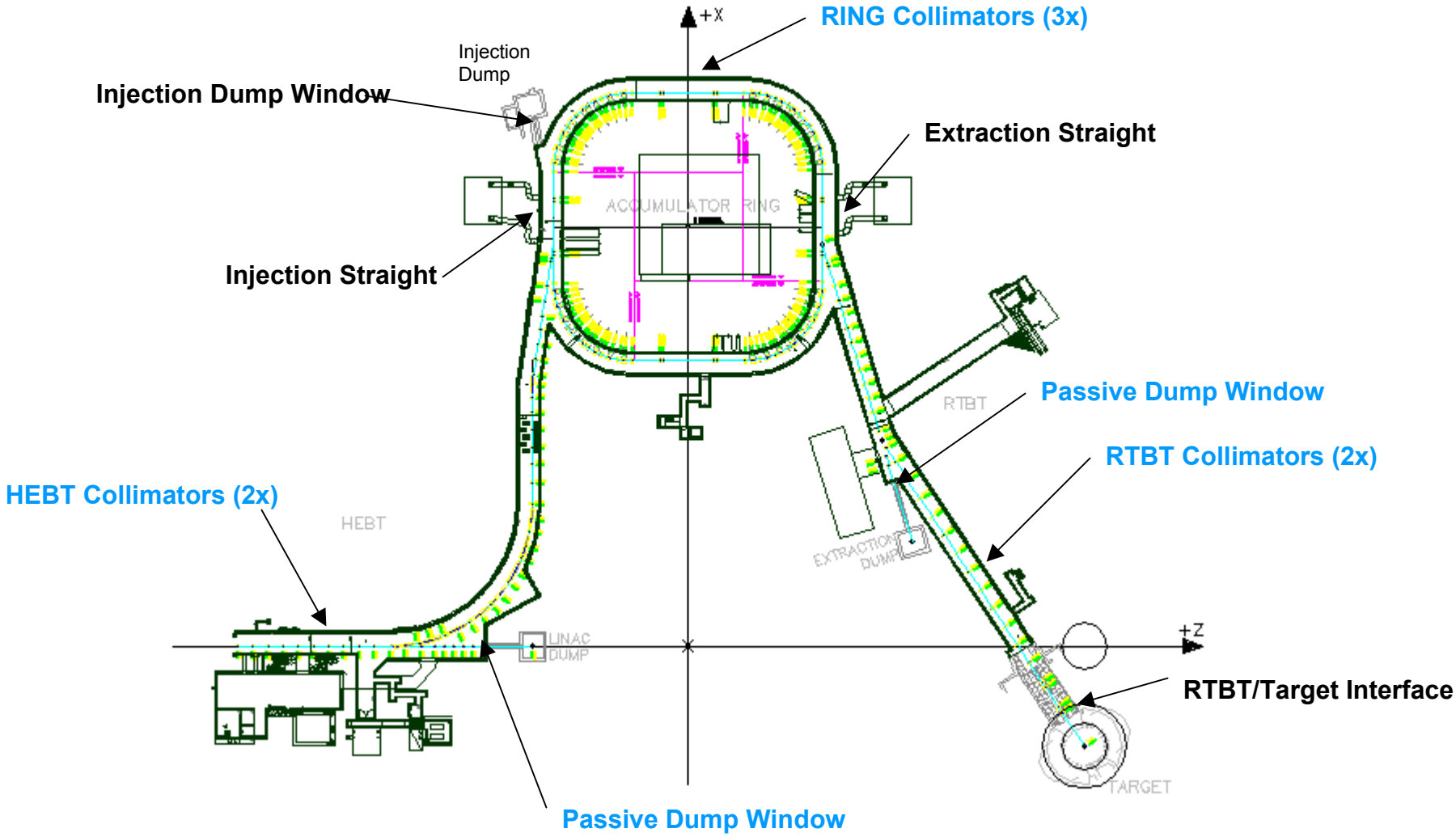
The Spallation Neutron Source

- The SNS will begin operation in 2006
- At 1.4 MW it will be ~8x ISIS, the world's leading pulsed spallation source
- The peak neutron flux will be ~20-100x ILL
- SNS will be the world's leading facility for neutron scattering

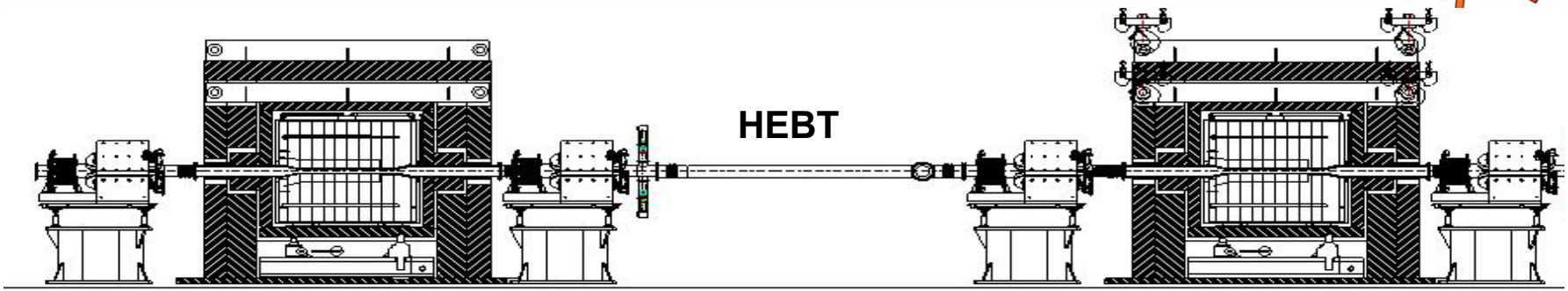
Accelerator – Active Handling Hot Spots

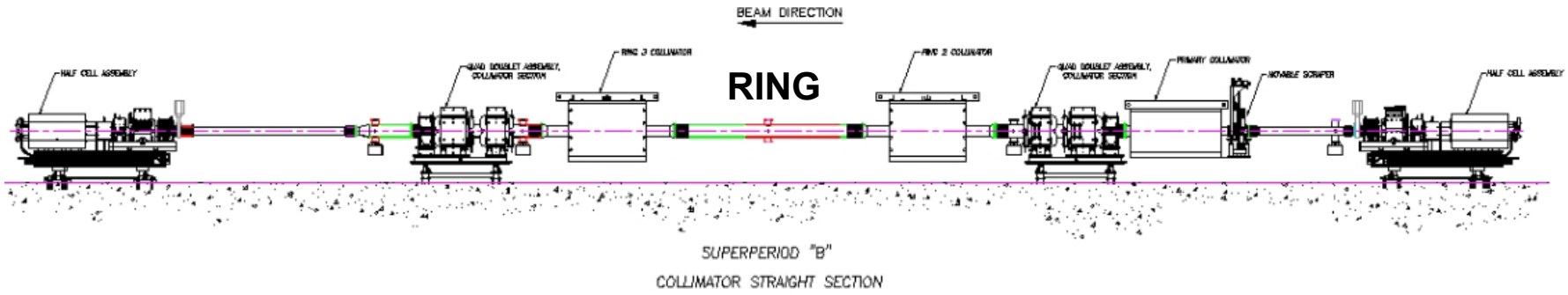
- HEBT Collimators (2 off)
- Linac Dump Window (1 off)
- Injection Straight Section
- Injection Dump Window (1 off)
- Primary Collimator & Moveable Scraper (1 of each)
- Ring Collimators (2 off)
- Extraction Straight Section
- Extraction Dump Window (1 off)
- RTBT Collimators (2 off)
- RTBT/Target Interface

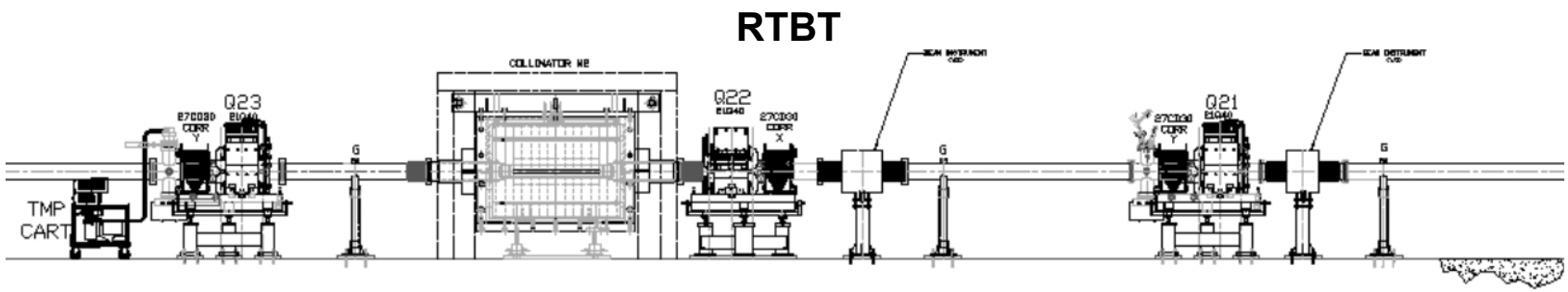
Ring Lattice



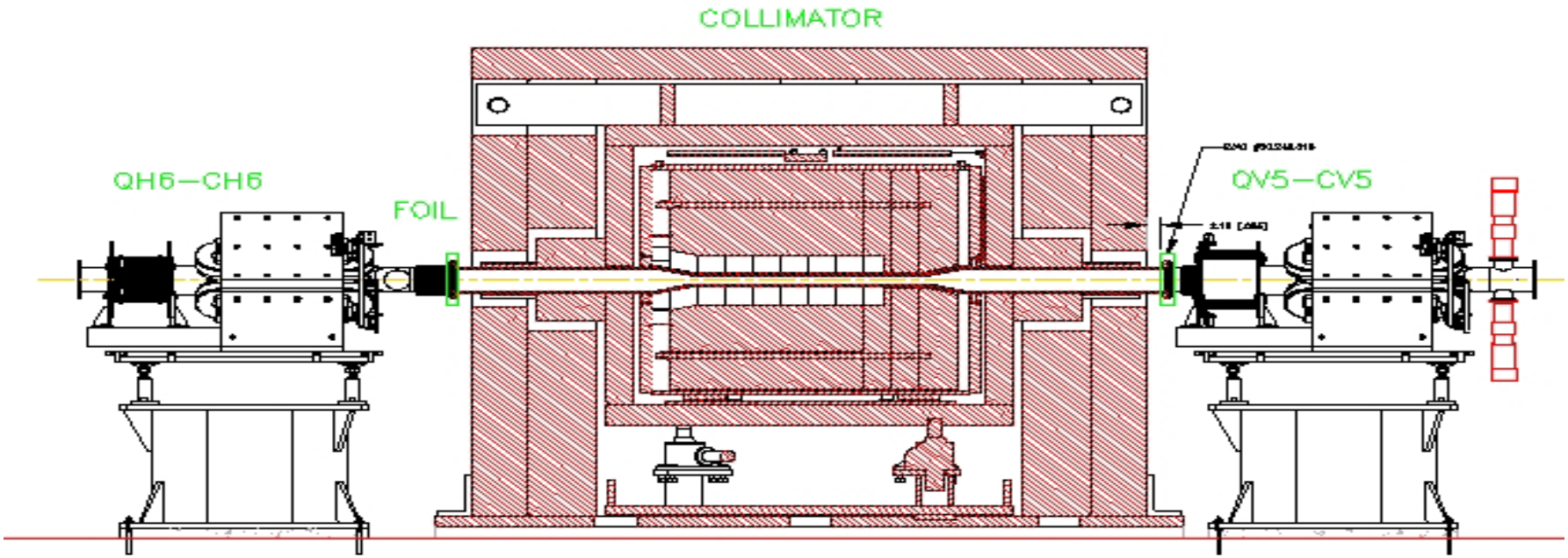
Accelerator Collimator Layout

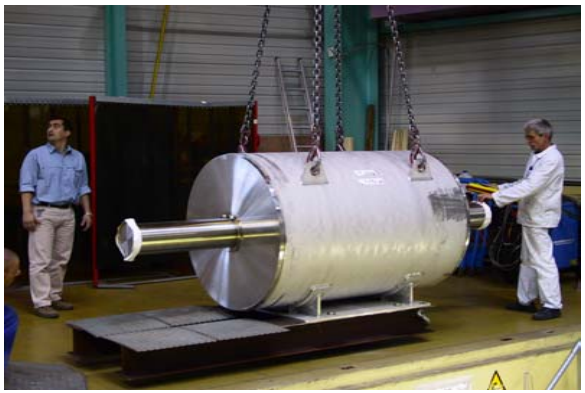




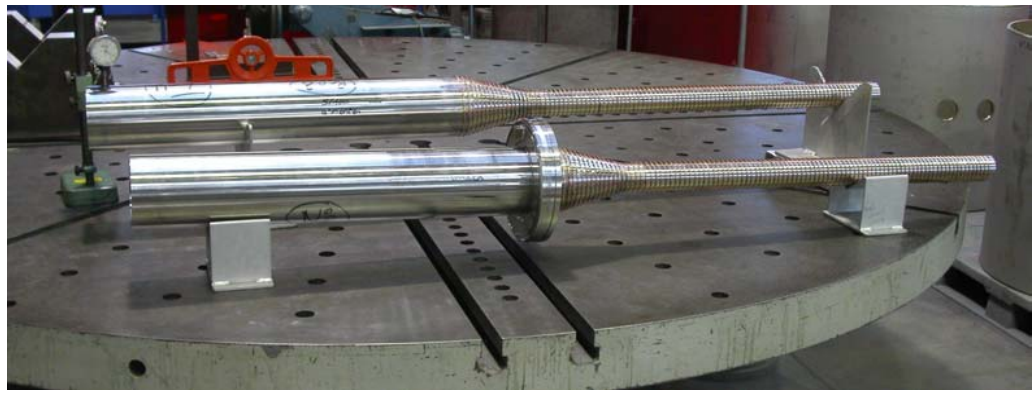


HEBT Collimators Layout





Collimator Body



Beam Tube

Collimator Removal Procedure & Design Status

- Remove QV09 & Beam Pipes
- Flush Water System

  CLOSED LOOP DOUBLE CONTAINED WATER SKID WITH BACK-FLUSH IN DESIGN
- Disconnect Water Flow/Return

  REMOTE WATER FITTING DESIGNED
- Disconnect Helium Pipe
- Disconnect Vacuum Clamps

  REMOTE VACUUM CLAMPS DESIGNED & BUILT, INTEGRATE TO EXISTING COLLIMATOR DESIGN
- Retract Upstream/Downstream Bellows?

  BELLOWS COMPRESSION TOOL DESIGNED, INTEGRATE TO EXISTING COLLIMATOR DESIGN
- Option – Remove Adjacent Components?
- Shield Beam Pipe/Vacuum Flanges
- Attach Crane to Outer Shielding

  INTEGRATED LIFTING FIXTURE/DUAL LIFTING EYES DESIGNED & INTEGRATED TO DESIGN
- Remove Front and Top of Outer Shielding (single lift)
- Attach Crane to Collimator

  INTEGRATED LIFTING FIXTURE/DUAL LIFTING EYES DESIGNED & INTEGRATED TO DESIGN
- Remove Collimator from Outer Shield
- Deposit into Shielded Cask

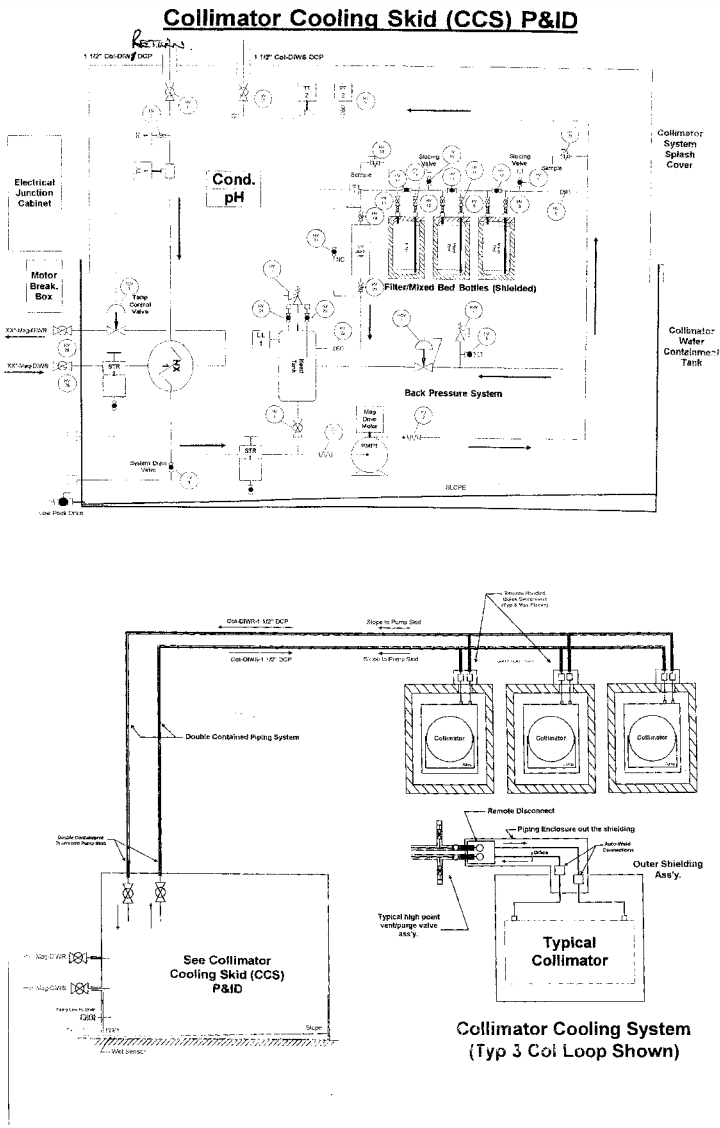
  NOT DESIGNED
- Deposit in Cask
- Seal Cask
- Remove from HEBT Tunnel on Transporter

  NOT PROCURED
- Store Cask in Designated Cool-down Area

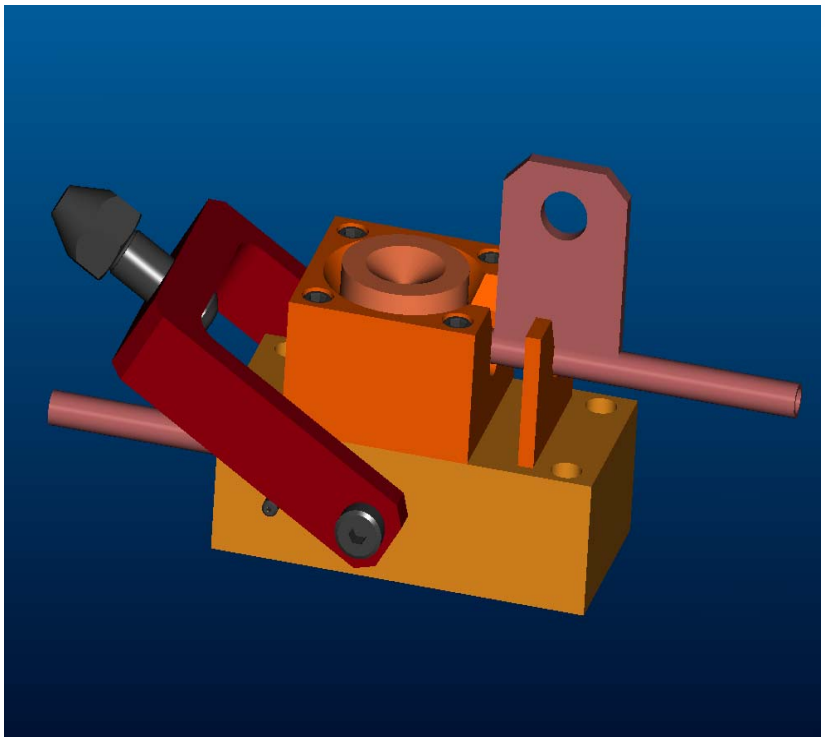
Collimator Closed Loop D/C Cooling Skid

SPECIFICATION

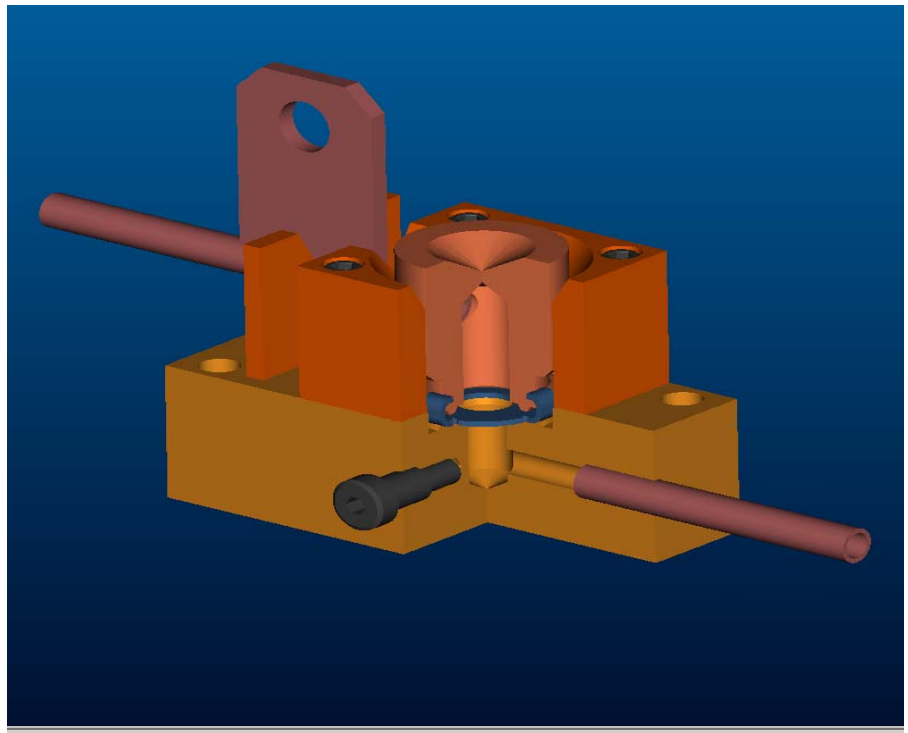
- Closed Loop System
- Self Contained – No Leaks
- Skid – Secondary Containment
- Pipe-work – Double Contained
- Pressurized Back-Flush
- Remote Location of Skid
- Sized to Suit Individual System
- Shielded Resin Beds
- Temperature & Pressure Control
- Conductivity - Monitored



Collimator Remote Water Fitting

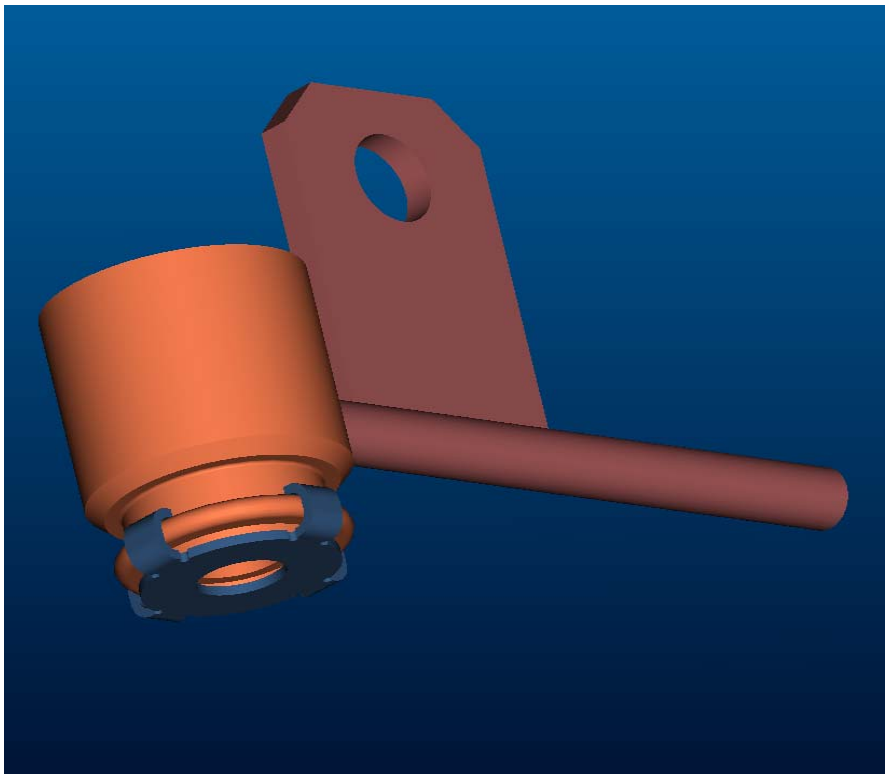


- Proven Design (ISIS Facility)
- Simple Connect/Disconnect

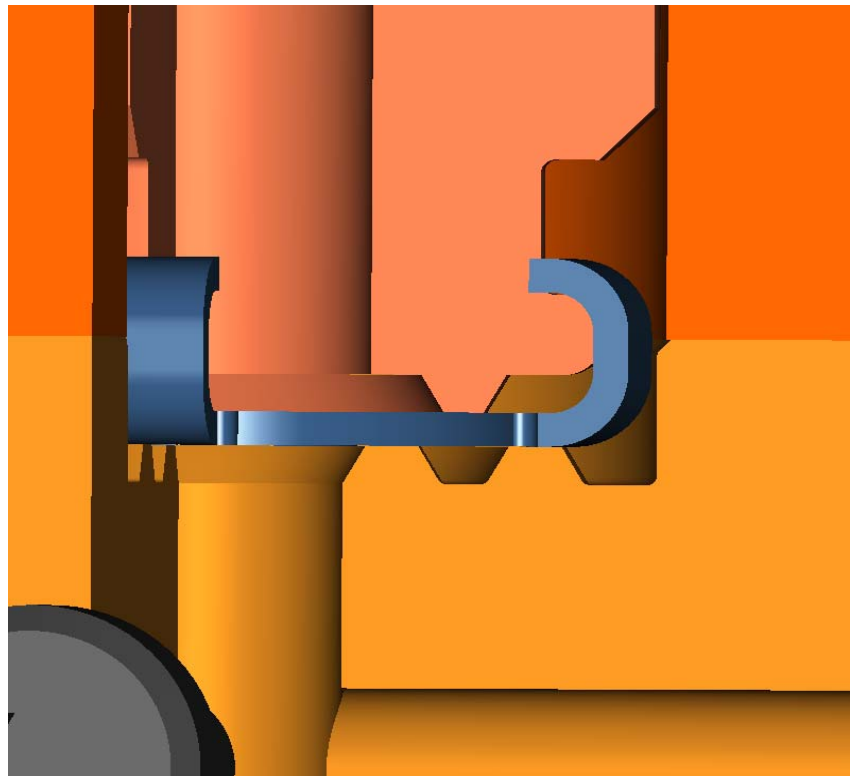


- Re-Design to suit Collimator Layout
- Minimum Torque Required for Reliable Seal

Collimator Water Fittings – Design Features

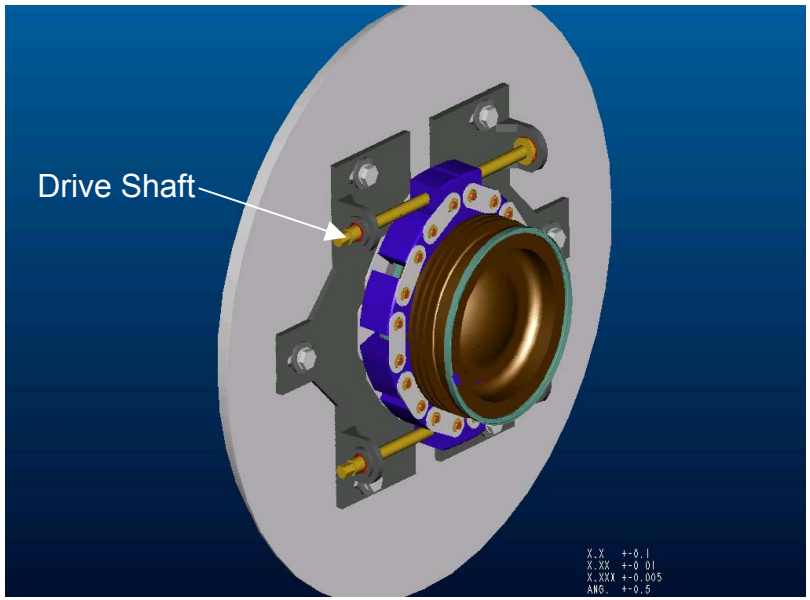


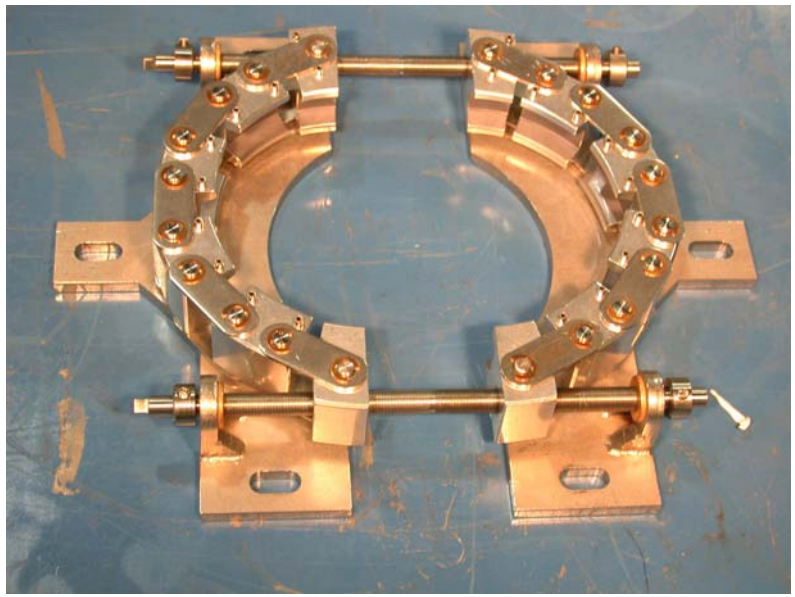
- Multiple Seal Faces
- Captive Copper Seal



- Attaches to Component
- Handling Tag

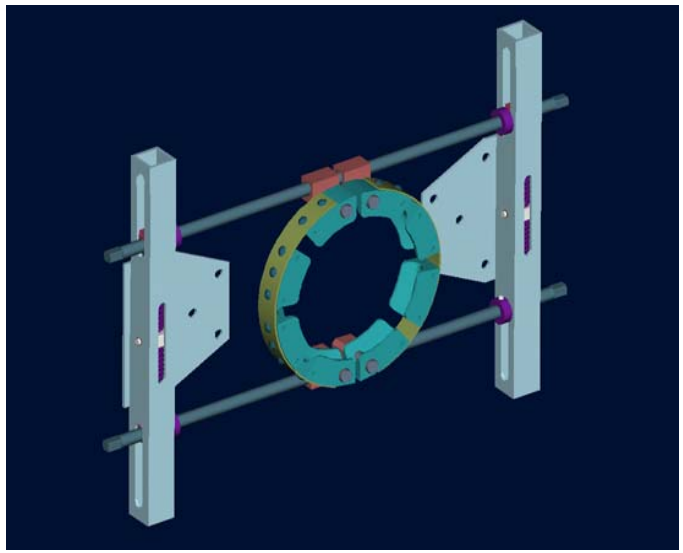
Remote Vacuum Clamps (Concept I)

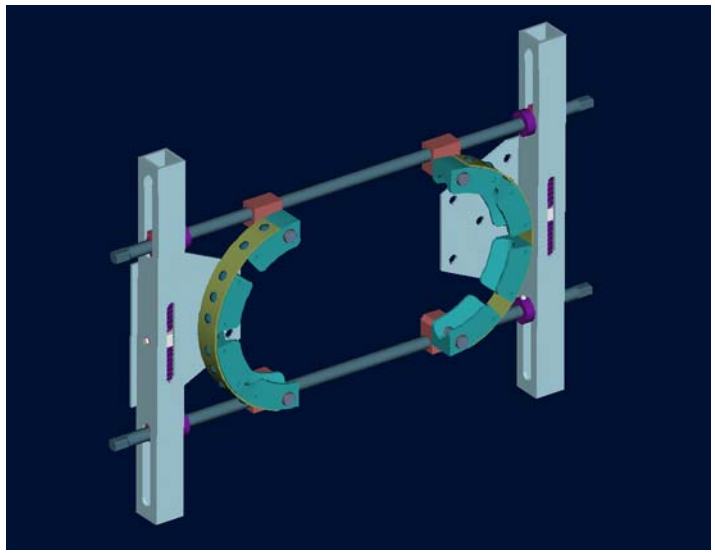




- Designed for Linac Passive Dump Window – Modify Design for Collimators
- Design Based on a Standard EVAC Chain Clamp (NW 125)
- Drive Shaft with Left/Right Handed Threads
- Designed to Bolt onto End Flange of Components
- Dowel Pins to Limit Shoe Sag
- Manufactured by EVAC under Contract
- Size Limited ?

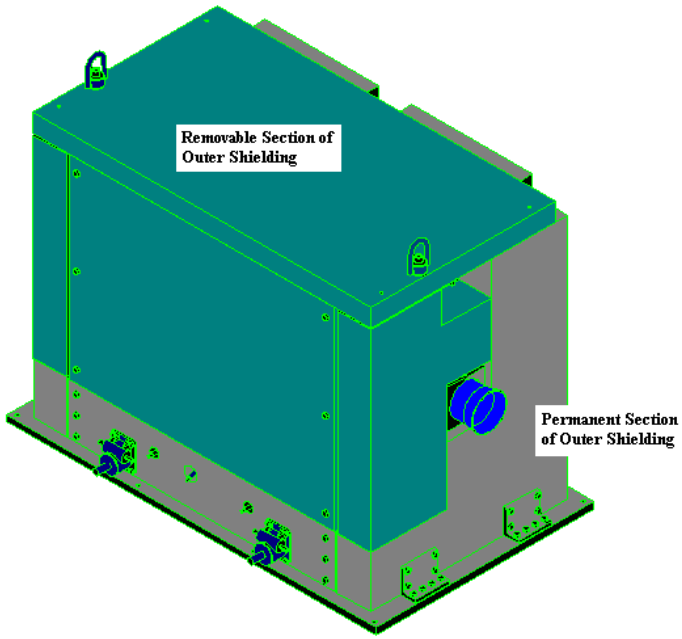
Remote Vacuum Clamp (Concept II)

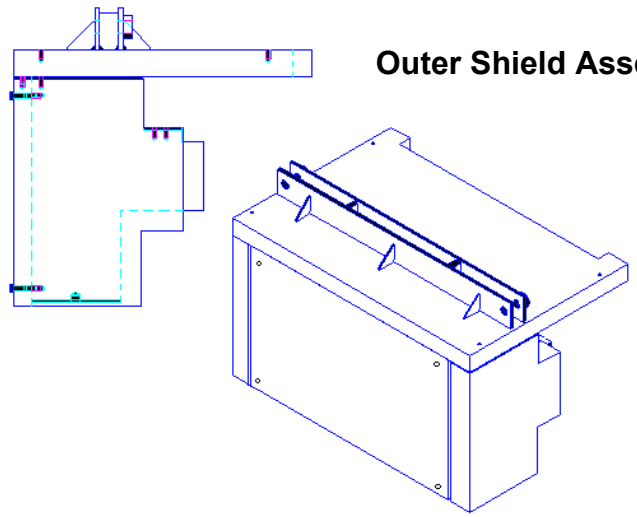




- Designed for Linac Passive Dump Window – Modify Design for Collimators
- Design Based on Ideas from BNL & ISIS
- Aluminum Shoes with Stainless Backing Band – Maintains Shape
- Drive Shaft with Left/Right Handed Threads
- Spring Loaded Drives – Allows Shoes to Open/Close around Flange
- Flange can be Vertically Removed
- Probably Easier to Scale Up in Size

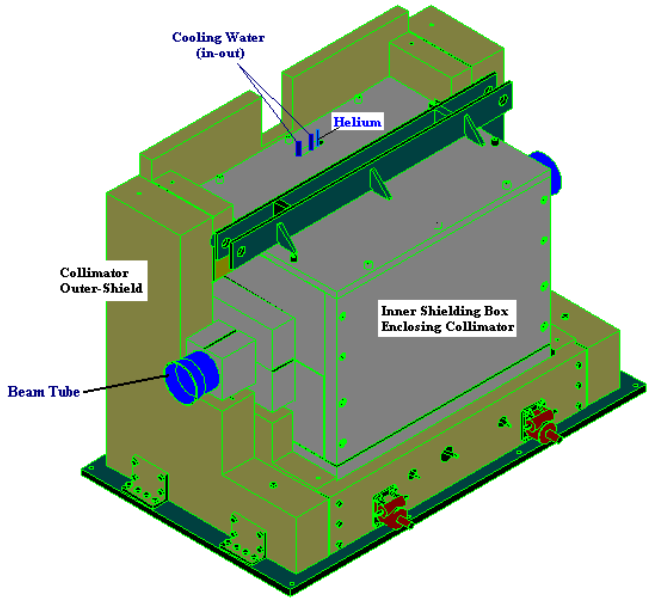
HEBT Collimator Lifting – Design Features

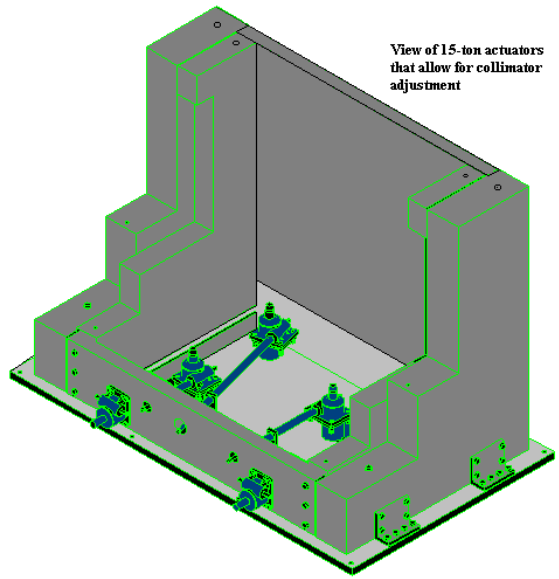




- Twin Hook Crane Picks up Outer Shield Integral Lifting Fixture/Shackles
- Outer Shield Assembly Designed to be Free-Standing
- Once Outer Shield is Removed Collimator can be Accessed

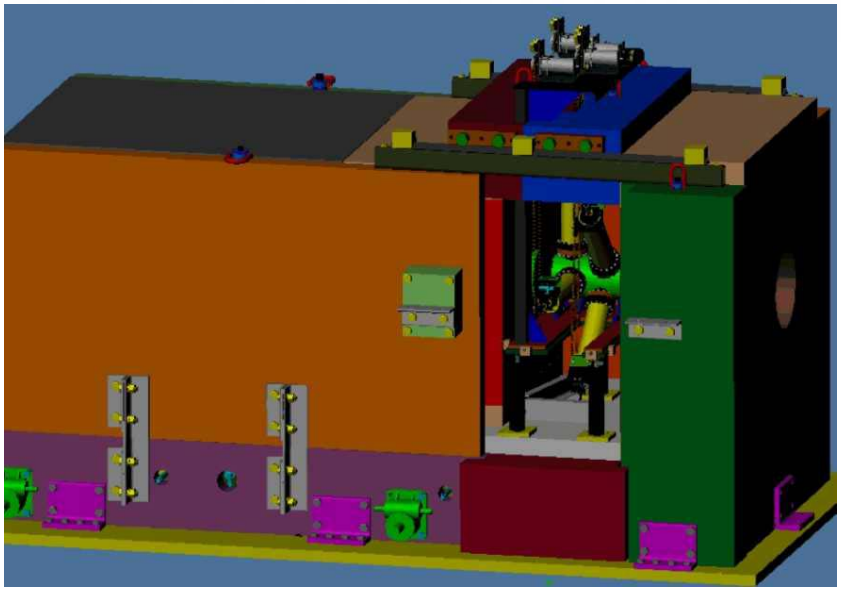
HEBT Collimator Lifting

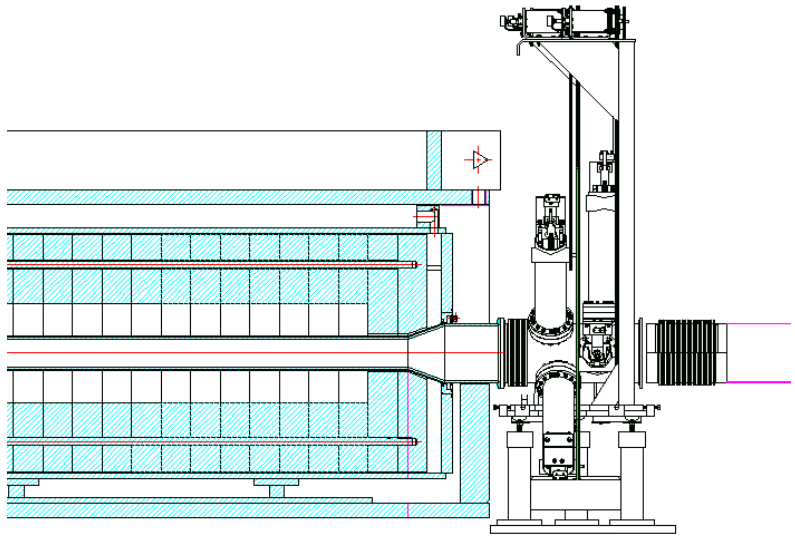




- Twin Hook Crane Attaches to Integral Lifting Fixture
- Collimator can be Lifted Out of Outer Permanent Shielding
- Three Mounting Jacks and Outer Shielding Ready to Accept New Collimator
- Jack Adjustment from Front Face of Collimator

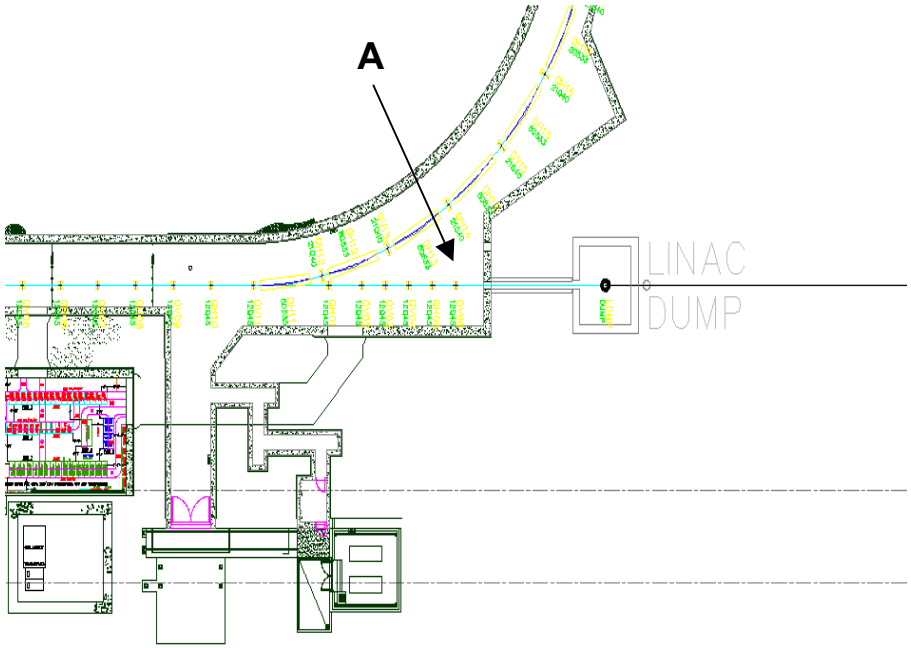
RING Primary Collimator & Moveable Scraper

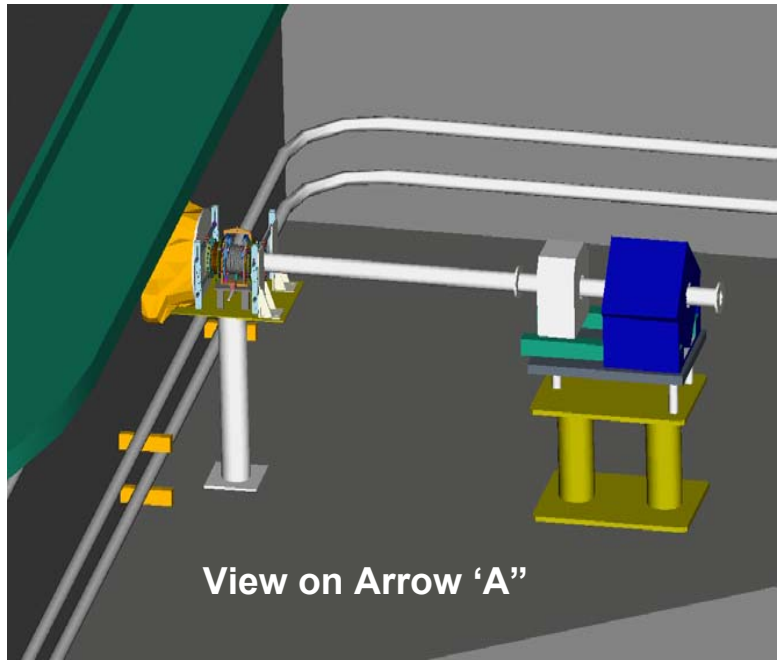




- Collimator & Scraper Mounted on Single Base Plate
- Motor Drives Outside Shielding
- Collimator & Shielding in Detail Design
- Remote Clamp Design to be Utilized
- Extremely Difficult Design due to Space Restriction
- Collaboration between ORNL/BNL

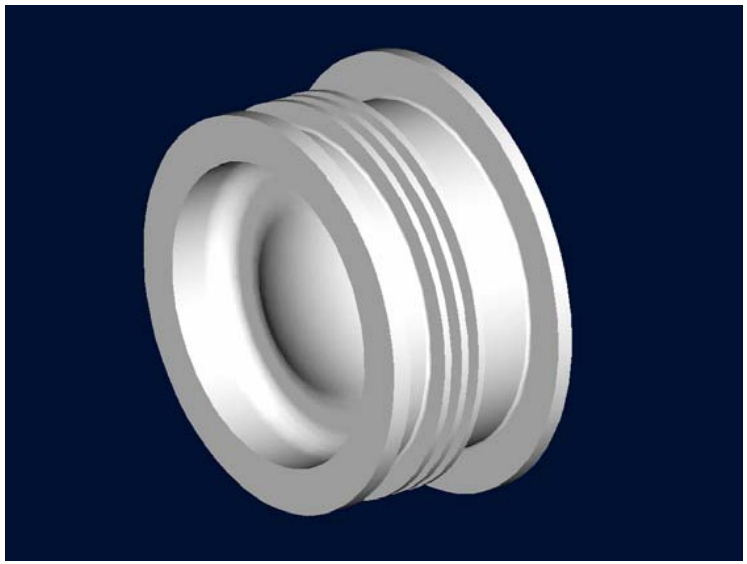
Linac Passive Dump Window





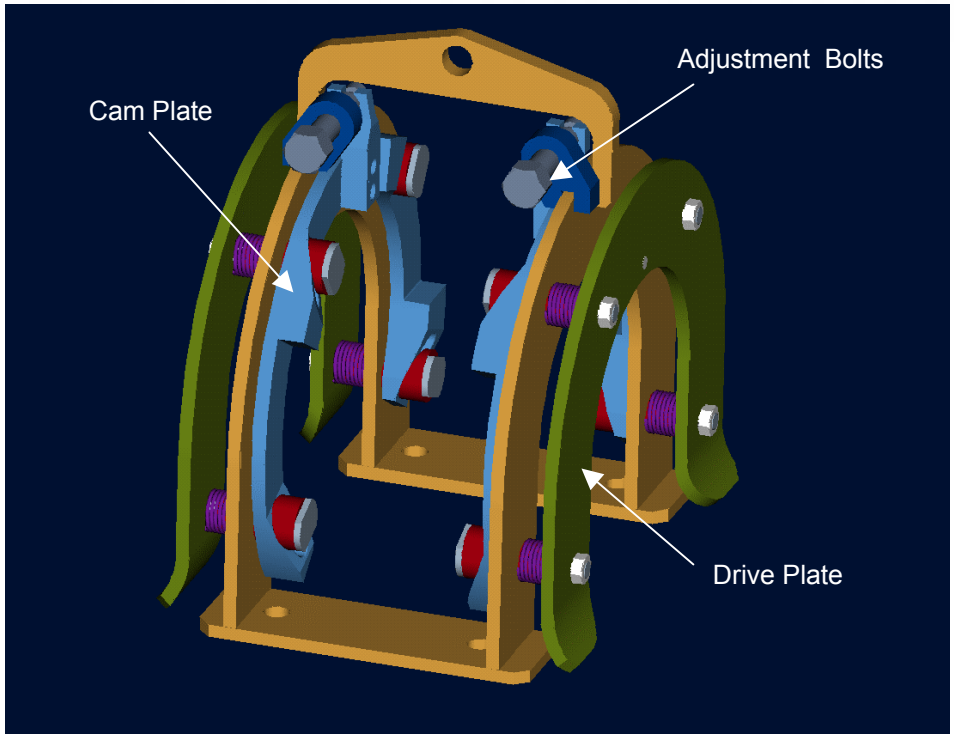
- Window Separates Accelerator Vacuum from Dump Flight Tube Medium
- Inconel-718 Domed Window may require Removal/Replacement
- Remote Vacuum Clamps & Bellows Compression Mechanism Required
- Design used as Development Model for Collimator Equipment – Smaller Size

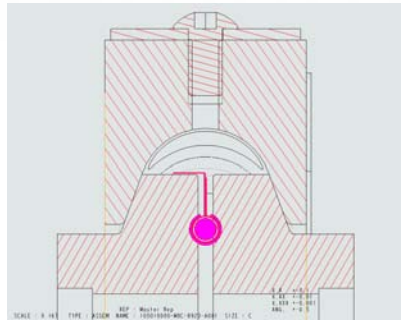
Passive Dump Window



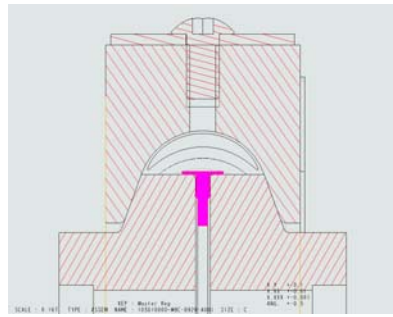
- Window Incorporated into Bellows & Flange Assembly (~Ø165mm x 300mm)
- Full Assembly Replaced if Window Fails
- Pick-Up Flanges Added for Mechanism Manipulation
- Design Underway for Captive Seals to be Added to Window Assembly
- Options – EVAC Aluminum Diamond & Helicoflex Delta

Window Assembly Cradle & Seals





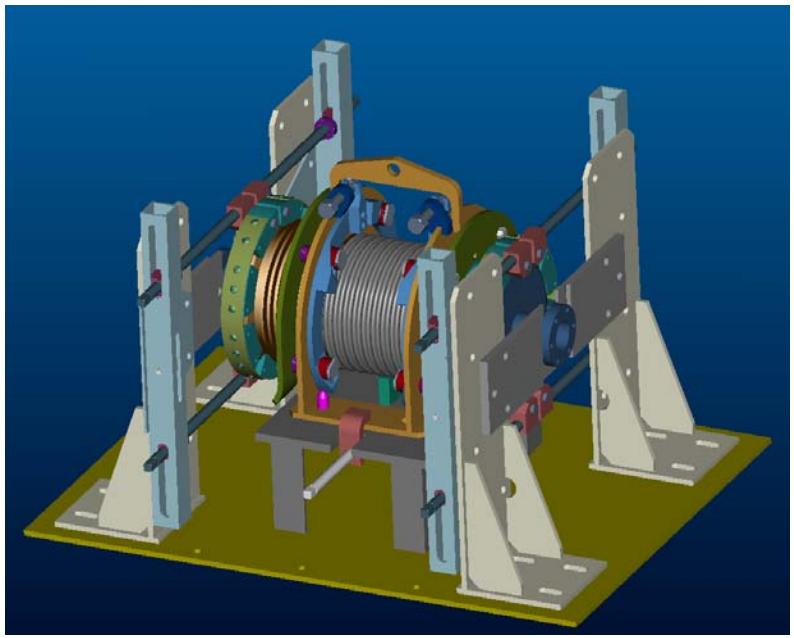
Helicoflex Delta Seal & EVAC Flange

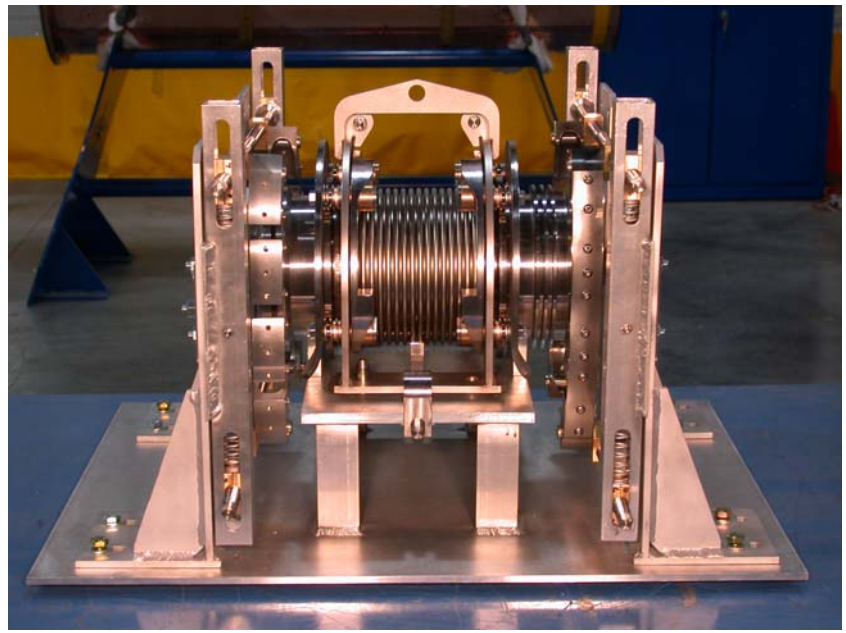


EVAC Diamond Seal & EVAC Flange

- Adjustment Bolts Rotate Cam Plate which moves Outer Drive Plates Axially
- Springs Assist Movement
- Cradle Locates on Dowel Pins to React Forces
- Drive Plates Incorporate Pins that Locate in Window Assembly
- Diamond Seal or Delta Seal can be Tested

Window Change Mechanism Test Rig





- Test Rig Designed & Built to Test Both Clamp Designs and Bellows Compression Mechanism
- Window Change Scenario can be Tested and Validated
- Vacuum Integrity Validated
- Cradle Straddles Window Assembly, Compresses & Retains Bellows
- Cradle Lifted out with Window Assembly attached

Tunnel Status

HEBT Tunnel Looking Downstream

Linac Dump Alcove & HEBT Tunnel

Summary

- HEBT, RING(standard) & RTBT Collimators – Design Finished
- RING Primary Collimator – In Detail Design
- Moveable Scraper – 1st Article Fabricated, Production Drives in Fabrication
- Collimator Cooling Skid – Specification Ready for Procurement
- Remote Water Fittings – Design Finished, Ready for Manufacture
- Remote Vacuum Clamps – Prototype Built, Testing this Week
- Bellows Compression Mechanism - Prototype Built, Testing this Week

Future Work/Challenges

- Validate Water Fittings, Vacuum Clamps & Bellows Mechanism
- Incorporate Variations of Above to Existing Collimator Designs – Facilitate Safe Handling
- Design Extraction Passive Dump Window and Handling Equipment
- Incorporate Clamp Design into Primary Collimator/Scraper Design (BNL/ORNL)
- Address RTBT/Target Interface & Handling Issues (BNL,LANL,ORNL)
- Work with BNL on Injection/Extraction Straight Sections

Acknowledgements

- A. Decarlo, K. Potter, T. Roseberry, J. Schubert, Oak Ridge National Laboratory
- J, Brodowski, H. Ludewig, J. Tuozzolo, N. Simos, Brookhaven National Laboratory
- J. Hirst, Rutherford Appleton Laboratory